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Pulmonary arteriovenous fistula with bilharzial pulmonary hypertension

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Congenital pulmonary arteriovenous fistulae, provided that they are not present in very large numbers, are best managed surgically, and there is no effective alternative management. Where pulmonary arteriovenous fistulae develop as a consequence of pulmonary hypertension it is rational to resect the fistulae if the cause of pulmonary hypertension – for example, mitral stenosis – is correctable. Pulmonary arteriovenous fistula in the presence of unexplained or uncorrectable pulmonary hypertension may be the safety valve on which life depends and should, therefore, not be resected. An example is reported of pulmonary arteriovenous fistula associated with bilharzial pulmonary hypertension in which resection of the fistula resulted in death.

Fistulous communications between branches of pulmonary arteries and veins within the lung may be congenital, when they represent vascular hamartomata, or acquired, when there is no certain evidence that fistulae develop on the basis of septal hypoplasia.

Congenital pulmonary arteriovenous fistula is a haemangiomatous malformation of the pulmonary vascular bed, and is commonly a manifestation of multiple hereditary haemorrhagic telangiectasis or Rendu-Osler-Weber disease. While occasionally found in the newborn, first recognition is usually after puberty; the lesion is usually more than a distended sack fed by an end-artery and drained by a vein, and is often part of an intricate vascular anomaly which affects neighbouring vessels and sometimes even the chest wall. Fistulae usually abut on the pleura; adjacent parenchyma is little disturbed.

The extent of dislocation of circulatory physiology depends on the size of the right-to-left shunt. One large, several small, and many minute fistulae may produce the same physiological disturbance. The percentage of right ventricular output shunted through the fistula varies widely – from 18 to 90 per cent in reported cases. In otherwise normal subjects probably 30 per cent of blood must be shunted past the pulmonary capillary bed before clinically detectable cyanosis will develop. Arterial oxygen unsaturation, within certain limits of anoxia, stimulates the erythropoietic elements of the bone-marrow and produces polycythaemia. In contradistinction to systemic arteriovenous fistula there is, with pulmonary arteriovenous fistula, an increase in total blood volume which is due only to increase in red cell volume. The response of the haematopoietic system in these circumstances is similar to that produced by high altitudes.

A pulmonary arteriovenous fistula is a right-to-left extracardiac shunt which bypasses the pulmonary capillary bed and allows unoxygenated blood to enter the left atrium. The circulatory dynamics are, therefore, the same as in anomalies of venous return to the left atrium. Systemic arteriovenous fistulae decrease total systemic resistance and, therefore, increase the work of the heart and increase cardiac output and size. The vascular resistance of the lungs, however, is normally so low that the presence of a shunt in parallel with pulmonary resistance does not significantly reduce the over-all vascular resistance of the lungs, unless the vascular resistance of the shunt is unusually low. In most patients with congenital pulmonary arteriovenous fistula pulmonary artery pressure and systemic blood flow are normal and there is not an increase in cardiac size. Pulmonary vascular resistance is often a little raised, and the reason for this is not clear. It is known that hypoxaemia will produce pulmonary arteriolar constriction, and it is also known

that, in circumstances of polycythaemia, as in tetralogy of Fallot, pulmonary vascular resistance may be increased from small multiple thrombi which reduce effective pulmonary blood flow. Therefore, though the heart is usually normal in patients with congenital pulmonary arteriovenous fistulae, it is important to recognize that it may enlarge when the resistance offered to flow through the fistula is unusually low or where over-all pulmonary vascular resistance is significantly increased.

Pulmonary arteriovenous fistula is recorded in association with mitral stenosis. Lindgren (1946) and Steinberg and McClenahan (1955) quoted examples of pulmonary arteriovenous fistula in patients with mitral stenosis, and three of six previously reported examples of pulmonary arteriovenous fistula (Le Roux, 1959) had mitral stenosis. In two of these patients the mitral stenosis was diagnosed clinically and shown surgically to be severe; in the third it was estimated clinically to be mild. It has been maintained that the development of pulmonary arteriovenous fistula in the presence of pulmonary hypertension, the consequence, for example, of mitral stenosis, may result from the rupture of hypoplastic vascular septa in patients with a generalized vascular dysplasia; may represent increase in the size of shunt through an already established small pulmonary arteriovenous fistula; or may represent enlargement of anatomically normal arteriovenous shunts known to exist in most organs at precapillary level. In the lung these shunts are most numerous at the apices of the segmental subdivisions, in the visceral pleura, and at the level of the respiratory bronchioles. By means of *in vivo* perfusion experiments using glass spheres 20 to 40 times the diameter of the lumen of capillaries, Prinzmetal *et al.* (1948) have shown arteriovenous shunts in the lungs, and in most other organs in many mammals. Gas analysis studies in man have confirmed these findings, and the passage through the lungs of large particles such as clumps of tumour cells and certain parasites, particularly *Schistosoma cercariae*, has commonly been cited as evidence of their existence.

While, therefore, it remains debatable whether pulmonary arteriovenous fistula can develop in the presence of pulmonary hypertension without the pre-existence of hypoplastic septa between arteries and veins, it is clinically well established that the lesion is found in two separate circumstances: one in which pulmonary arteriovenous fistula is associated with other manifestations of a congenital vascular hypoplasia, and the other in which the pulmonary arteriovenous fistula develops in the presence of pulmonary hypertension.

Pulmonary hypertension in relation to bilharzia is well recorded (Shaw and Ghareeb, 1938; Cavalcanti *et al.*, 1962; Turner, 1964; Chaves, 1966; Winship, Kallichurum, and Lapinsky, 1969); the pulmonary lesions are found in association with *Schistosoma mansoni* and *Schistosoma haematobium*; the histological features of pulmonary bilharzial hypertension are parenchymatous pseudotubercles which lie in close proximity to small pulmonary arteries in which there are bilharzial ova, which are either calcified or ingested by foreign body giant cells. It is often not possible to identify the ova in respect of species and some of the pseudotubercles are necrotic. In addition to the granulomatous lesions, there is diffuse intimal hyperplasia, medial thickening, and thrombosis, with organization in the arterioles and muscular arteries. Diffuse intimal thickening of arterioles not directly related to ova are also seen; larger arteries show medial and adventitial thickening. Bilharzial pseudotubercles, with or without ova, need not be numerous, and obliterative changes which involve arteries not directly related to pseudotubercles may be particularly striking. In many of the reported examples 'angiomatoid' lesions typical of chronic pulmonary hypertension are found in relation to the tubercles, and in these the vessels are dilated and thin walled. It is probable that pulmonary hypertension, when it develops in relation to bilharziasis, is a manifestation of individual hypersensitivity rather than a result of mechanical obstruction of the pulmonary vascular bed. The angiomatoid lesions were once thought to be a distinctive feature of bilharzial arteriolitis but probably result from recanalization of obliterated vessels and are a non-specific result of severe pulmonary hypertension from any cause (Heath and Edwards, 1958).

An association between bilharzial pulmonary hypertension and pulmonary arteriovenous fistula has not been found on scrutiny of available published papers.

Case report

An 11-year-old African girl was admitted to hospital in April 1967 with a history of progressive dyspnoea on effort and cough for a year. Six months earlier she had had fever and joint pain; she denied haematuria or previous gastro-intestinal upsets. Radiographic features were those of cardiomegaly, prominent proximal pulmonary arterial segments, and a left peripheral, lobulated,

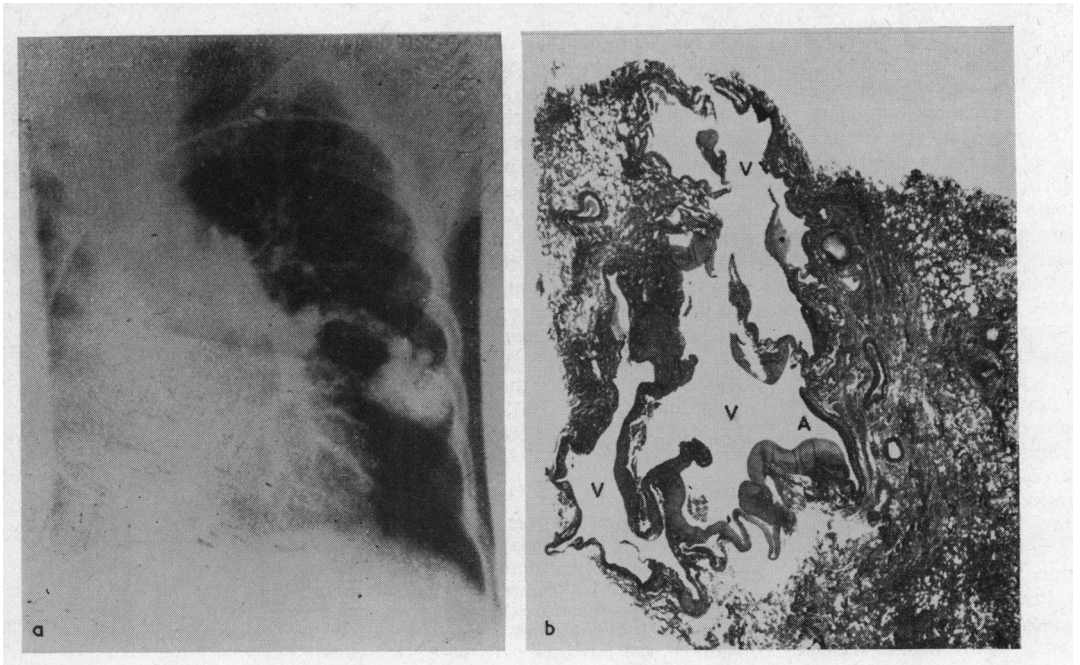
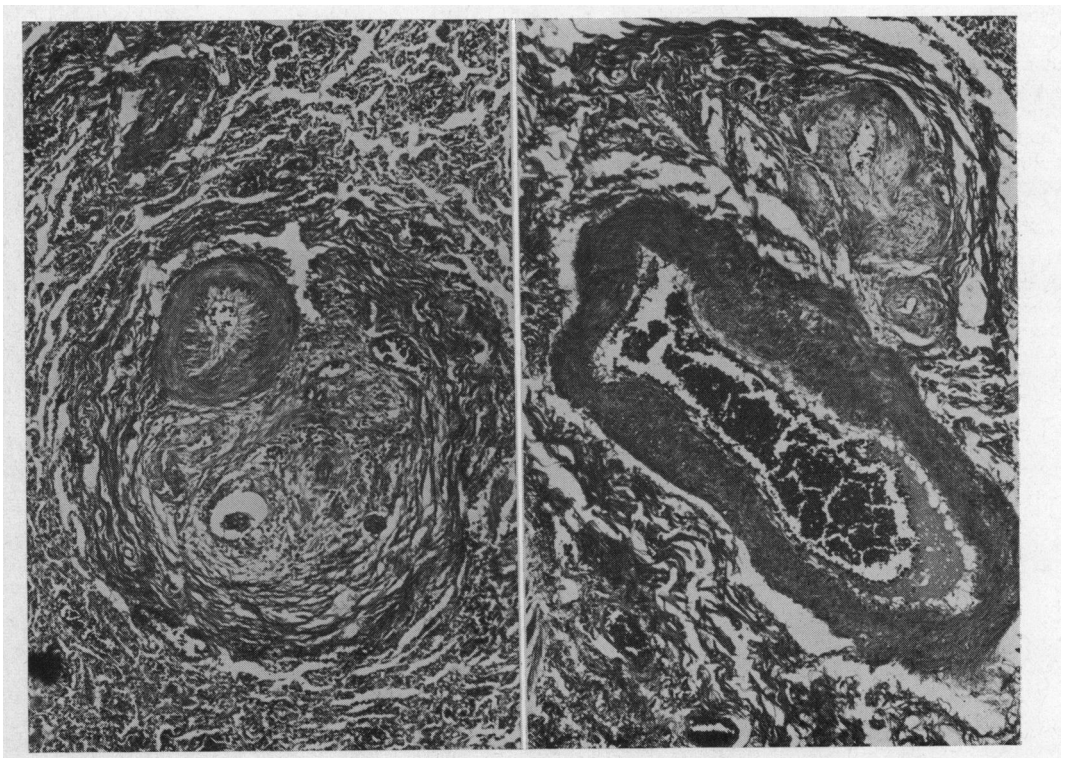


FIG. 1a *The pulmonary arteriovenous fistula has been shown at angiocardiography.*

FIG. 1b *Arteriovenous fistula in which the artery (A) is shown opening into a grossly dilated vein (V).*

FIG. 2a *Granulomatous focus around two bilharzial ova, adjacent to a small pulmonary artery. (H. and E. ×60.)*

FIG. 2b *Late angiomatous lesion adjacent to pulmonary artery. (H. and E. ×80.)*



pulmonary opacity suggestive of a pulmonary arterio-fistula. The child was thin and undernourished; her fingers were normal; she was not cyanosed and did not have angiomatous malformations of skin or mucosae. There was a prominent 'A' wave in the neck; the systemic blood pressure was normal; there was a moderate right ventricular lift and a palpable second heart sound. The first heart sound in the mitral area was loud, with an ejection systolic click. There was an ejection systolic murmur, grade 3–6, maximal at the second left interspace but also heard along the left sternal border. At the apex this murmur was replaced by a continuous murmur which increased in intensity with deep inspiration, and was diminished by the Valsalva manoeuvre. The features of the electrocardiogram were those of right atrial and right ventricular hypertrophy. Cardiac catheterization showed moderate pulmonary arterial hypertension (mean pressure 50 mm. Hg), with a pulmonary vascular resistance of 25 units, a right-to-left shunt of 0·8 litres per minute, and moderately severe arterial desaturation (72%); a large left-sided arteriovenous fistula was shown by cine-angiocardiography (Fig. 1); it lay in the lingular segment of the left upper lobe.

The child was observed for two months in hospital and during this time the heart size was thought to have diminished. There was radiographic evidence of increase in size of the opacity shown to be that of an arteriovenous fistula. Resection of the fistula was, therefore, undertaken.

Through a standard left thoracotomy, through the bed of the 6th rib without rib resection, the vascular anomaly was seen on the lateral surface of the lingular segment. The fistula was deflated by ligation of the lingular artery. Formal lingulectomy was undertaken by division of the bronchus and vein. The bronchus was closed proximally with interrupted silk and the closure buried in pleura. The vein was divided between ligatures and the segments stripped out cleanly without bleeding. At this stage the heart began to fail; the pericardium was opened and an isoprenaline drip started; the heart recovered quickly, without the need for cardiac massage. The left atrium was seen to be normal; thrills were not appreciated on the surface of the heart; the left ventricle was very much smaller than the right. As a manifestation of sublime hind-sight the operation note ends: 'There can be no doubt that there is very much more wrong with this child than pulmonary arterio-venous fistula, and this is either incidental or a safety valve in a patient with obliterative pulmonary vascular disease'. Though the child recovered consciousness, left ventricular function remained unsatisfactory in early convalescence, and isoprenaline was required to maintain a reasonable cardiac output. The child deteriorated and died 12 hours after operation.

The resected specimen, which contained the arteriovenous fistula (Fig. 1b), was shown histologically to bear the features of bilharzial granulomata (Fig. 2a), angiomatous lesions (Fig. 2b), and vascular sclerosis.

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